Single Season Multi-State Occupancy Case Study – Estimating Occupancy and Breeding Propensity of California Spotted Owls.

Project Description and Context

In this module, we'll fit models that use the multi-state (single-season) model using data from California spotted owls (*Strix occidentalis occidentalis*) collected in the central Sierra Nevada during the breeding season of 2004. The sampling situation involved searching for owls at potential territory sites (54 sites) and drawing inferences about the occupancy status of each site. We define 3 possible true states: 0=unoccupied, 1=occupied with no production of young, and 2=occupied with successful reproduction. At each visit to a site, the result of the site visit was classified into one of the following observation states: 0=no detection, 1=detection of the species with uncertain state assignment, and 2=detection of the species in state 2, with no uncertainty associated with state assignment. The data are included in the sample data folder that is installed along with PRESENCE in the Excel spreadsheet **Cal_Owl_MultiState_data.csv**.

The interest in estimating occupancy and breeding probability was to estimate the proportion of breeding pairs that produce young. This can be done using the multi-state occupancy model because potential owl territories are inhabited by a single breeding pair. So, the proportion of sites where breeding occurs can be translated into the proportion of pairs which produce young.

Under consideration were 6 a priori models to describe the processes that gave rise to the detection history data. Detection was modelled as constant(.), state-dependent(s), or time-dependent(t). Classification parameters (d) were modeled as constant (.), time-dependent (t), or partially time-dependent (ie., one value for times 1 and 2, and another value for times 3-5). The rational for the partially time-dependent model was that successful reproduction would be very difficult to detect in the early portion of the breeding season, but much more readily detected later.

References:

Nichols, J. D., Hines, J.E., MacKenzie, D.I., Seamans, M.E., and R.J. Gutierrez. 2007. Occupancy Estimation and Modeling with Multiple States and State Uncertainty. Ecology, 88(6): 1395-1400.

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Exercise Objectives

- Learn how to create and run occupancy models with multiple states and state uncertainty
- Learn to import data and investigate possible patterns of time variation
- Continue to increase comfort level and familiarity with all aspects of analysis in PRESENCE from data exploration to model selection, and interpretation of results

Presence spreadsheet data file: **Cal_Owl_MultiState_data.csv**

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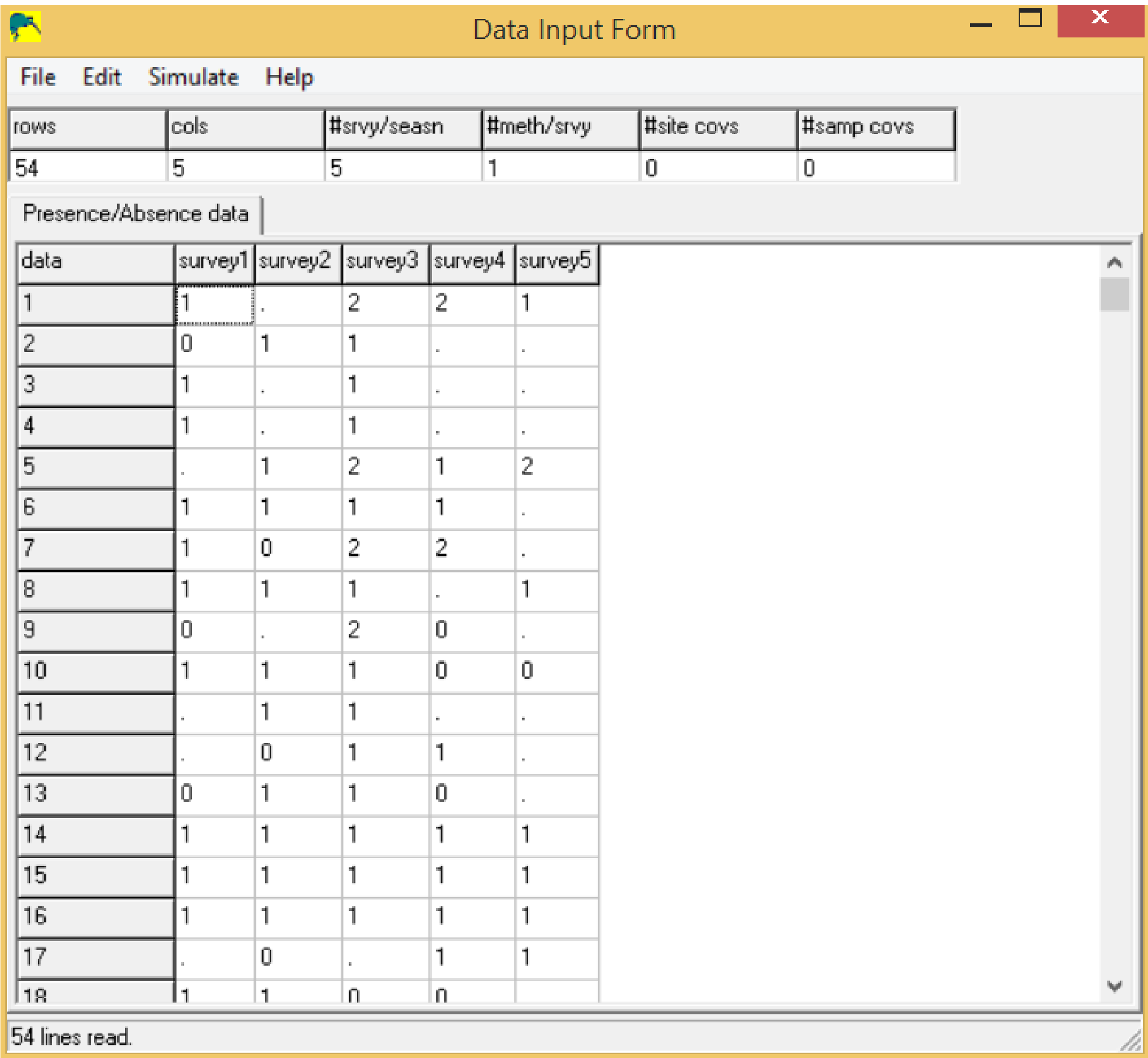
INSTRUCTIONS

Step 1 – Data Import: Begin PRESENCE, start a new project and open the data input form. Import the csv file directly by using the 'File' menu, then 'Open'. When the file selection dialog box appears, change the file type from 'Presence input file (pao)' to 'Comma Delimited (CSV)'. Find the file, 'cal_owl_multistate.csv', and click the 'Open' button. Since the CSV file is in the exact format that PRESENCE uses, it can be input in this manner (without cut/paste). This is a way to avoid the problem with the 32,000 character clipboard limit for very large input files.



rows	cols	#srvy/seasn	#meth/srvy	#site covs	#samp covs
54	5	5	1	0	0

data	survey1	survey2	survey3	survey4	survey5
1	1	.	2	2	1
2	0	1	1	.	.
3	1	.	1	.	.
4	1	.	1	.	.
5	.	1	2	1	2
6	1	1	1	1	.
7	1	0	2	2	.
8	1	1	1	.	1
9	0	.	2	0	.
10	1	1	1	0	0
11	.	1	1	.	.
12	.	0	1	1	.
13	0	1	1	0	.
14	1	1	1	1	1
15	1	1	1	1	1
16	1	1	1	1	1
17	.	0	.	1	1
18	1	1	0	0	

Save the data file using an appropriate name (I used 'CalOwl'), click 'No' to indicate that the spreadsheet does not contain site frequencies, then close the data input form which will return you to the **Enter Specifications for PRESENCE Analysis** window. Select the data file you have just created, add a title for the project, then click 'OK'. After a couple of seconds a blank results browser should appear. Remember, if you do not see the results browser, you have not successfully set up your project file.

Step 2 – Data Exploration:

Bring back the Data window (**View>Data**) and notice that some sites contain 2's, indicating that breeding was detected at the site, and some sites only contain 1's and 0's. Just as sites with all zeros may be occupied, sites with only 0's and 1's may be breeding sites. Although there are no covariates for this data set, they are allowed in PRESENCE.

Step 3 – Running a simple model : First, let's fit a simple model where the probability of occupancy and breeding are the same for all plots and the probability of detection and probability of detecting breeding activity are the same in all surveys. In our earlier notation we could call this model **psi(.)R(.)p(.)delta(.)**. The design matrix for occupancy will now contain 2 rows with 1's on the diagonal (occupancy different from breeding probability). The detection design matrix will contain 10 rows and 1 column (detection constant over the surveys), and the classification probability (delta) will contain 5 rows and 1 column. After the design matrix appears you just need to hit 'Ok to Run' then confirm the results to add them to the results browser.

Exercise:

1. As there are no covariates for these data, possible models involve either time and/or state-specific detection (p), or time-specific probability of correct assignment of breeding status (δ) (see 3rd paragraph). Working in small groups, fit the models described below:
    a. Ψ(.)R(.)p(.)δ(.)
    b. Ψ(.)R(.)p(t)δ(.)
    c. Ψ(.)R(.)p(s)δ(.)
    d. Ψ(.)R(.)p(.)δ(1-2,3-5)
    e. Ψ(.)R(.)p(t)δ(1-2,3-5)
    f. Ψ(.)R(.)p(s)δ(1-2,3-5)

    Note: p(s) -> p varies by 'state'(non-breeding or breeding).

2. Calculate the summed AIC weights for models with/without the restricted time effect on delta.

3. Is there support for the hypothesis about the difficulty in detecting breeding during the first two surveys?

4. Before the development of these models, biologists estimated reproductive rate as the ratio:

   (number of sites with successful reproduction detected [detection history contains at least 1 ‘2’])

   (number of sites with owls detected [detection history not all ‘0’])

   Does this estimator differ much from our estimate that deals with nondetection and misclassification? If you were projecting population change using a population model, do you think this difference would matter much?